REMARKS/ARGUMENTS

Claims 1,2,4,6,8, and 10-23 are pending in this Application. Claims 13-18 and 20-21 are withdrawn from consideration. (Claims 11-12 had been previously withdrawn from consideration, but are now being brought back into prosecution, as will be discussed below).

Claims 1,2,4,6,8, 10,19, and 22-23 stand rejected. Specifically, Claims 1-2, 4, 6, 8, 19 and 22-23 are rejected under 35 U.S.C. 103(a), as being unpatentable over Hamada (JP 11-217644); and Wheaton (U.S. 3,561,955), in two separate rejections. In another, separate rejection, Claim 10 is rejected by a combination of Hamada and Twigg et al (U.S. Patent 3,723,108). Applicant believes that the current set of claims defines patentable subject matter, and it is hoped that these remarks and any subsequent communication with the Examiner will further clarify such subject matter.

A brief review of the claimed invention may be useful at this time. The nickel-based alloys of this invention were formulated for high-temperature applications for various turbine components. One important goal for the inventive alloys was to provide an alternative to cobalt-based alloys. While the latter materials are also valuable in many high-temperature systems, they are sometimes deficient in selective properties important for specific applications. For example, cobalt-based alloys, while possessing a number of good properties such as strength and weldability, are sometimes deficient in creep strength, and can be susceptible to thermal fatigue cracking. This may be the case for certain sections of turbine nozzles, as described in paragraph 3 of the present specification. Thus, finding a good substitute for the cobalt alloys was a serious challenge for the inventors, since the substitute material had to possess a particular combination of strength, corrosion resistance, weldability, and creep resistance. Moreover, the new alloy composition needed to be economically viable, and within certain weight guidelines.

The presently-claimed nickel alloys also contain aluminum, titanium, niobium, and chromium. In some preferred embodiments, these alloy systems also contain selected amounts of cobalt, and/or zirconium. Relatively minor elements of other elements are also sometimes included, as recited, for example, in claim 6.

In some primary embodiments – especially for certain turbine engine applications - the alloys of this invention require at least three distinctive characteristics or "inclusions". First, they require the presence of selected amounts of a core "sub-group" of elements – aluminum, titanium, and niobium. As described in paragraph 14 of the specification, this group of elements provides some of the key strengthening mechanisms for the alloy composition, via the presence of the gamma-prime (γ') phase.

Second, the atomic ratio of aluminum to titanium must be within the range of 0.5 to about 1.5, in preferred embodiments. As described in paragraphs 9 and 13, for example, the maintenance of such a ratio, along with the specified content levels for each element, results in the decrease or elimination of undesirable alloy phases, such as the hexagonal crystal eta (η) phase. This in turn can lead to improvements in creep resistance, as well as high-temperature stability, as also described in the specification, in the indicated sections. (As noted in Table 1 and paragraph 36 of the specification, metallographic and image characterizations of samples of the invention clearly showed the presence of the desirable gamma-prime (γ') phase, with a minimum of the undesirable eta (η) phase).

A third important feature of the invention is the specified absence of tantalum in the alloy composition. While tantalum can be an important constituent in a variety of nickel-based alloys, its presence in most embodiments of the present invention is undesirable (see paragraph 16 of the specification, for example). In many instances, the presence of tantalum, a relatively dense element, can unnecessarily add to the weight of components made from the alloy, and any excess weight in parts such as aircraft turbine components can be problematic. Moreover, tantalum, a relatively expensive element, can also unnecessarily add to the cost of the alloy composition.

Furthermore, the present inventors discovered that the elimination of tantalum in these particular alloy systems can result in a very large increase in creep strength. Figure 1 of the Application is based on an experiment regarding that premise. The removal of tantalum from comparative samples resulted in a 200% increase in this important property.

Applicants submit that the simultaneous presence of these three, primary characteristics is neither disclosed nor suggested in the prior art. Therefore, the present

claims have been structured around these limitations. The references which are currently cited should be analyzed in view of the currently-expressed inventive features.

The contents of Hamada are as described in a translation which was apparently supplied by the Patent Office. In brief, the reference is directed to alloy compositions which are used as combustor liners for gas turbines. The alloys appear to be based on chromium, cobalt, molybdenum, tungsten, aluminum, titanium, tantalum, niobium, hafnium, and carbon, in addition to nickel. Ranges for these elements are provided in paragraph 17, as pointed out by the Examiner. Hamada also describes the presence of aluminum and titanium, in the formation of the gamma prime phase (paragraph 22). The reference also provides a number of examples which compare various alloy properties, such as high temperature strength, elongation, oxidation resistance, weldability, and ductility (paragraphs 80, 84, 104, and 118, for example).

Applicant acknowledges that there is some overlap between some of the constituents of the present invention, and those of Hamada. However, the present invention is distinguishable in a number of key respects. First, Hamada, in allowing for 0% of titanium and niobium, does not specifically require the presence of these elements. As noted above, titanium and niobium are key core-elements for the present invention. Moreover, it should be noted that the reference is clear about which elements are required, and which are optional. For example, see paragraphs 28 and 29 of Hamada, wherein chromium and nickel, respectively, are noted as being "indispensable". No such indication is provided for titanium or niobium.

Second, the reference fails to disclose or suggest the specific requirement of the present invention, regarding aluminum-titanium ratios. While the desirable presence of the gamma prime phase is mentioned in Hamada, the elimination or minimization of the eta phase does not appear to be suggested. The absence of this inventive feature is understandable in some respects. While Hamada is directed to some physical properties similar to those of the present invention, the reference is not directed to alloy compositions which have especially-enhanced creep resistance (see paragraph 9 of Applicant's specification).

Moreover, Hamada has nothing to do with alloys which must be free of tantalum, which is another important feature of the present invention, discussed above.

While Hamada mentions the possibility of problems with excessive amounts of tantalum, the reference clearly allows for its presence (see paragraphs 23 and 30, for example). Moreover, tantalum is notably listed as a constituent in compositions listed in Table 1, Table 5, and Table 7. Nothing in Hamada shows recognition that the elimination of tantalum can lead to highly-increased creep strength, as in the present invention.

Claim 10 has been separately rejected by a combination of Hamada and Twigg et al ("Twigg"), U.S. Patent 3,723,108. Twigg had been discussed in previous prosecution, and had been distinguished over the previously-cited references. (The reference describes certain nickel-chromium alloys. In addition to other differences, a key distinguishing feature from the present claims was the absence of tungsten in those alloys). In the present instance, it appears that Twigg is being applied for its mention of boron levels.

Twigg does in fact mention boron, at a prescribed level. However, the presence of boron does not appear to be a primary feature in any embodiment of the patent. Moreover, the combination of that specific teaching with the teachings of Hamada still fails to suggest the key features of the present claims, noted above.

Claims 1,2,4,6,8, 10,19, and 22-23 stand rejected under 35 U.S.C. 103(a), as being unpatentable over Wheaton (U.S. 3,561,955). The patent describes nickel-based alloys which also include chromium, tungsten, molybdenum, niobium (columbium), tantalum, titanium, and aluminum. While the alloys are formulated to provide high temperature strength and ductility (the latter, at intermediate temperatures), the primary characteristic apparently sought after is resistance to sulfidation (col. 1, lines 32-37; col. 2, lines 51-56, for example).

As in the other references described previously, Wheaton includes elements which overlap some of the ranges for those same elements in the present invention. However, the reference is distinct in other important respects. Wheaton mentions particular titanium-aluminum levels to promote the gamma prime phase (col. 3, lines 10-19), but no suggestion is made of Ti-Al proportions which minimize or prevent formation of the eta phase. Instead, Wheaton appears to be very much involved with the elimination of the "sigma phase" (col. 2, lines 20-32; col. 4, lines 6-11), which is an alloy phase very different from the eta phase.

Moreover, Wheaton clearly allows for the presence of tantalum, as shown, for example, in column 5, lines 22-29. In contrast, the present invention specifically calls for the absence of tantalum. Wheaton contains no suggestion that eliminating tantalum can greatly improve creep strength, and this is a fundamental feature of the present invention, as noted above. Again, while this reference relates to the same general field as the present invention, it is directed to a different set of performance issues and alloy phenomena, i.e., sulfidation and the formation of the plate-like sigma phase.

Several more brief notes are appropriate. First, claims 11 and 12 have been brought back into this case, by amendment. They are directed to certain, specific embodiments of the invention. A review of the prosecution by the undersigned indicates that the claims initially may have been withdrawn, pursuant to a Restriction Requirement. However, in their present state, they appear to be part of the same inventive concept as that in claim 1, and can be considered in this prosecution.

Second, Applicant notes that a recently-uncovered reference is being provided under separate cover, in a supplementary Information Disclosure Statement ("A Study of the Balanced States in the NiCrTiAlW System"). For the convenience of the Examiner, a copy of the one-page reference is attached hereto. While it is believed that the reference should not affect patentability in this situation, it was deemed material enough to submit to the Patent Office.

Applicant submits that the remaining, rejected claims (and the two additional claims brought back into the case) should now be in allowable form. After reviewing this Response, it may be helpful for the undersigned and the Examiner to see if any remaining issues can be quickly resolved, by way of a telephone conference.

Please charge all applicable fees associated with the submission of this Response, and any other fees applicable to this Application, to the Assignee's Deposit Account No. 07-0868.

Respectfully submitted,

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Title : A Study of the Balanced States in the NiCrTiAlW System,

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Abstract : The work deals with the NiCrTiAlW system, with the tungsten content varying from 0 to 15 at.% and with a different Ti/Al ratio, studied at a temperature of 850 C. A phase analysis of 101 alloys, annealed at 850 C to the state of equilibrium, was made by optical and electron microscopy and by the X-ray method. The results show that in addition to the permanent eta and gamma' phases present in the solid solution of nickel, there exists the phase alpha which, according to the X-ray phase analysis and the X-ray probe spectral microanalysis, represents the W-base solid solution. In the above system, the phase is stable even at 850 C, whereas the Ni4W phase has not been observed at this temperature. It is concluded that the range of the alpha-phase, in the quinternary system, increases toward the lower temperatures. Applying the X-ray probe spectral microanalysis indicated that the solubility of Ni in the alpha-phase of the studied system is 2%. Similarly, the eta phase was able to dissolve further elements, mainly Cr and W, and solubility of these elements in the eta-phase was greater than zero. The solubility of W in the basic solid solution gamma at various Ti/Al ratios, was 8 at. %. (Author)

Descriptors : *HEAT RESISTANT ALLOYS, PHASE STUDIES, NICKEL ALLOYS, CHROMIUM ALLOYS, TITANIUM ALLOYS, ALUMINUM ALLOYS, TUNGSTEN ALLOYS, X RAY DIFFRACTION, CZECHOSLOVAKIA, CZECHOSLOVAKIA.

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